(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 005 257 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.05.2000 Bulletin 2000/22

(51) Int. Cl.[7]: **H05G 1/34**

(21) Application number: 99308855.8

(22) Date of filing: 08.11.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 25.11.1998 US 199733

(71) Applicant:
PICKER INTERNATIONAL, INC.
Cleveland, Ohio 44143 (US)

(72) Inventor: Morgan, Hugh T.
Highland Heights, Ohio 44143 (US)

(74) Representative: Waters, Jeffrey
Marconi Intellectual Property
Waterhouse Lane
Chelmsford Essex CM1 2QX (GB)

(54) Computed tomography

(57) A CT scanner includes a stationary gantry (A) defining an examination region (12) and a rotating gantry (C) which rotates about the examination region. Multiple fan beam generators (B), each capable of producing a beam of radiation directed through the examination region, are mounted to the rotating gantry. The radiation beams are collimated (42) into a plurality of parallel thin fan shaped beams that are projected through the examination region. X-rays are detected by at least an arc of x-ray detectors or a plurality of parallel rings of detectors (14_1, 14_2,...14_n). The detectors generate signals indicative of the radiation received which are processed by a reconstruction processor (18) into a volumetric image representation for display on a monitor (20). In one embodiment, the signals are reconstructed into a series of spaced parallel slices. The object is indexed and additional slices are collected and reconstructed between previously reconstructed slices. In another embodiment, the region of interest moves such that each beam traverses a spiral path spanning one of a plurality of contiguous slabs. The multiple fan beam generators may be contained within a single elongated x-ray tube. Alternatively, the multiple fan beams can be generated by a plurality of angularly displaced x-ray tubes.

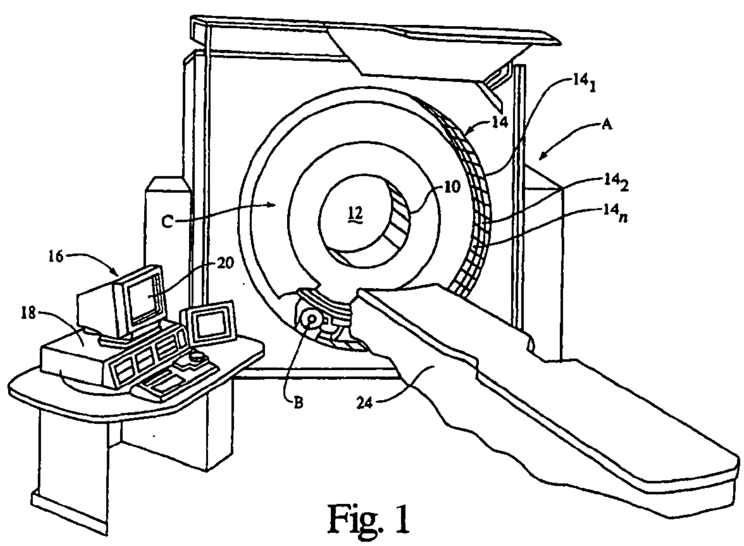

Fig. 1

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Description

[0001] The present invention relates to computed tomography (CT), especially for diagnostic imaging. The invention finds particular application in conjunction with volume CT imaging for medical purposes and will be described with particular reference thereto. However, it is to be appreciated that the present invention will also find application in conjunction with industrial, security, and other types of volume imaging apparatus and techniques.

[0002] In diagnostic imaging with CT scanners, a thin, fan shaped beam of radiation is projected from an x-ray source through a region of interest. The radiation source is rotated about the region of interest such that the same thin slice of the region of interest is irradiated from a multiplicity of directions spanning 360°. In a third generation scanner, an arc of radiation detectors is mounted to the same gantry as the radiation source such that the two rotate together. In a fourth generation scanner, the x-ray detectors are mounted stationarily in a ring 360° around the subject.

[0003] To image a volume of interest, a single slice image is typically generated. After a first slice image is generated, a subject support is indexed by a slice width generally on the order of a few millimetres, and another slice is generated. This slice image and index technique is repeated until slices spanning the volume of interest are generated. One drawback to this type of imaging is the relatively long time necessary to generate a large plurality of slices. Because the first and last slice are taken at a significantly different time, the volume image is distorted by a time evolution of the region of interest.

[0004] In spiral scanning techniques, the patient is generally moved continuously through the x-ray beam as the x-ray source rotates around the region of interest. In this manner, the fan shaped beam of radiation and the region of interest move in a spiral pattern relative to each other. The continuous motion is faster than indexing between slices, but still relatively slow.

[0005] In order to reduce the imaging time, some scanners collimate the beam of radiation into two slices. When the beam of radiation is collimated into two slices, two sets of radiation detectors disposed end to end are commonly provided. Typically, the thickness of the irradiated slice and the spacing between slices are adjustable. Such adjustments are relatively straightforward for two beams of radiation. However, the requirement that each beam of radiation strike only a single set of radiation detectors renders collimation into more than two beams mechanically awkward. Moreover, because the two beams originate from a common focal point, they are divergent, not parallel to each other. The divergent rays complicate and introduce errors into reconstruction techniques in which data is reconstructed into parallel slices. Moreover, as radiation from a single source is collimated into more beams, such beams become more widely divergent.

[0006] Systems have been proposed for examining the region of interest with a cone beam of radiation. However, cone beam image reconstruction is computationally intensive and slow. Moreover, cone beam imaging has a fixed resolution, based on detector size. Further, cone beam reconstructions tend to suffer from insufficiency of data problems, image artifacts, and other reconstruction errors.

[0007] In accordance with the present invention, a CT scanner includes a stationary gantry portion defining an examination region. A rotating gantry portion selectively rotates about the examination region. A plurality of anode elements, associated with the rotating gantry portion for selective bombardment by an electron stream, generate a plurality of parallel x-ray beams. A plurality of x-ray detectors receive the x-ray beams which have passed through the examination region. The detectors generate signals indicative of the x-ray beams received and a reconstruction processor processes these generated signals into an image representation.

[0008] In accordance with the present invention, a method of diagnostic imaging includes concurrently generating a plurality of thin fan beams of penetrating radiation. The plurality of thin fan beams are passed through an examination region while the fan beams are concurrently rotating around the examination region. Each of the fan beams is detected after passing through the examination region and are used to generate electronic signals indicative of an amount of radiation which has passed through the examination region.

[0009] Ways of carrying out the invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of a continuous CT scanner system in accordance with the present invention;

FIGURE 2 is a diagrammatic illustration of a set of x-ray beams produced according to the present invention;

FIGURE 3 is a detail of a fourth generation CT scanner in accordance with the present invention;

FIGURE 4 is a cross-section of a multiple anode x-ray tube suitable to meet the present invention;

FIGURE 5 is a diagrammatic illustration of an alternate set of x-ray beams produced in accordance with the present invention;

FIGURE 6 is a detail of an alternate embodiment of a fourth generation scanner according to the present invention;

FIGURE 7 is a cross-section of the scanner from FIGURE 6; and

FIGURE 8 is a block diagram of an exemplary control circuit suitable to practice the present invention.

[0010] With reference to FIGURE 1, a CT scanner includes a floor mounted or stationary gantry **A** whose position remains fixed during data collection. A multiple fan beam generator **B** is rotatably mounted on a rotating gantry **C**. The stationary gantry **A** includes a cylinder **10** that defines a patient receiving region **12**. A plurality of rings of radiation detectors $\mathbf{14_1}$, $\mathbf{14_2}$,...$\mathbf{14_n}$ are disposed concentrically around the patient receiving region **12**. In the illustrated embodiment, the radiation detectors are mounted on the stationary gantry portion such that a corresponding arc segment of the detectors receives each fan beam of radiation from the radiation source **B** which has traversed a corresponding parallel path through the examination region **12**. Alternately, as illustrated in Figure 2, a plurality of arc segments of radiation detectors can be mounted to the rotating gantry portion **C** each in alignment with one of the fan beams to rotate with the x-ray source.

[0011] A control console **16** contains an image reconstruction processor **18** for reconstructing a volumetric image representation using signals from the detector array $\mathbf{14_1}$, $\mathbf{14_2}$,... $\mathbf{14_n}$ for display on a monitor **20**.

[0012] The reconstruction processor 18 includes a plurality of reconstruction processors $\mathbf{18_1}$, $\mathbf{18_2}$,...$\mathbf{18_n}$, each preprogrammed using conventional slice image reconstruction algorithms. This is illustrated in Figure 2 for the case in which the detectors are configured as a set of axially spaced arcs of detector elements **(15)**, but applies equally to the stationary detector rings $\mathbf{14_1}$, $\mathbf{14_2}$ etc. The output from each of the detector rings $\mathbf{14_1}$, $\mathbf{14_2}$,...$\mathbf{14_n}$ is fed to a corresponding processor $\mathbf{18_1}$, $\mathbf{18_2}$,...$\mathbf{18_n}$ which reconstructs the data collected concurrently into a series of slices. The series of slices is then stored in a volume image memory **22**. If the x-ray beams are spaced immediately contiguous, then all of the slices of the volume image are reconstructed concurrently. However, in the preferred embodiment, the number of slices is less than the total number of slices in the volume and the slices are spread apart such that some fraction of the slices, e.g. every sixth slice, is generated concurrently. Thereafter, a patient couch **24** is stepped one slice distance and the next set of slices is generated concurrently. In the present example in which one sixth of the slices is taken each time, this process is repeated six times.

[0013] In another preferred embodiment, the slices are again spaced by some short distance. The patient table **24** moves in either direction through the imaging area or back and forth continuously as the x-ray beams rotate continuously. The motion of the patient table is selected such that the data collected by each of the radiation detectors spirals in each of a plurality of contiguous slabs. The data in each of the slabs is reconstructed, preferably concurrently by a plurality of parallel processors, using conventional spiral volume imaging algorithms.

[0014] In yet another alternate embodiment, the patient table moves back and forth a sufficient distance that the spirals overlap. The conventional spiral imaging algorithm is modified such that each of a series of preferably parallel processors is updating a corresponding region of volume image memory **22**, concurrently.

[0015] The video monitor **20** converts selectable portions of the reconstructed volumetric image representation into a two-dimensional human-readable display. The console **16** also includes appropriate tape or disk recording devices, performing image enhancements, selecting planes for viewing, 3-D renderings, or colour enhancements or the like. Various scanner control functions such as initiating a scan, selecting among different types of scans, calibrating the system and the like are also performed at the control console.

[0016] With reference to FIGURES 1 and 2, the x-ray generator **B** is elongated along an axis parallel to the examination region **12**. Multiple parallel fan-shaped beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$ are simultaneously produced. In the embodiments illustrated in Figure 2, both the generator **B** and the detector arcs $\mathbf{15_1}$, $\mathbf{15_2}$,...$\mathbf{15_n}$ are mounted to the rotating gantry **C**. Preferably, the rotating gantry **C** rotates the apexes of the beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$ about the examination region **12** and radiation data is collected by the detectors **15**. Volume scans are achieved by axially moving the couch **24** or region of interest through the examination region **12** and the plurality of x-ray beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$. Any number of x-ray beams may be generated, and the time required for a volume scan or coverage time is reduced by a factor proportional to the number of x-ray beams used.

[0017] FIGURE 3 depicts a single elongated x-ray tube **40** capable of generating n parallel fan-shaped x-ray beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$. The beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$ are generated and collimated by a collimator **42**. The collimator **42** is disposed adjacent to the x-ray beam source and channels the beams $\mathbf{30_1}$, $\mathbf{30_2}$,...$\mathbf{30_n}$ into a series of parallel axially spaced fan-shaped rays. The beams are attenuated as they pass through a subject **44** and are received by the plurality of axially spaced detector arrays $\mathbf{14_1}$, $\mathbf{14_2}$,...$\mathbf{14_n}$. The detector arrays $\mathbf{14_1}$, $\mathbf{14_2}$,...$\mathbf{14_n}$ generate electrical signals each proportional to the radiation received along a corresponding ray of each fan. Alternately, the detector arrays could be configured as semi-circular arcs **(15)** sufficient to receive the x-ray beam arc and could further be rotatably mounted to the rotating gantry portion in a third generation scanner (as shown in FIGURE 2).

[0018] Cross-referencing FIGURE 3 and FIGURE 4, the axially elongated x-ray tube **40** houses a plurality of rotating anode elements $\mathbf{60_1}$, $\mathbf{60_2}$,...$\mathbf{60_n}$. Each anode element $\mathbf{60_1}$, $\mathbf{60_2}$,...$\mathbf{60_n}$ is associated with a cathode assembly $\mathbf{70_1}$, $\mathbf{70_2}$,...$\mathbf{70_n}$, selectably excitable by a filament power supply **80**. When selected, each cathode assembly generates an electron stream which strikes

the corresponding anode element and produces x-ray beams. The x-ray beams are collimated by the collimator **42** into the plurality of parallel axially spaced x-ray beams $30_1, 30_2, \ldots 30_n$.

[0019] Alternatively, as seen in FIGURE 5, the radiation source generates axially spaced parallel x-ray beams $82_1, 82_2, \ldots 82_n$ that are angularly spaced from one another with respect to the examination region **12**. In the embodiment of Figure 6, a plurality of x-ray tubes $90_1, 90_2, \ldots 90_n$ are mounted onto the rotating gantry **C**. In a preferred embodiment in which n=3, the x-ray sources are evenly angularly separated at 120° intervals about the examination region **12**, but may be spaced at any offset angle. The fan beams $82_1, 82_2, 82_3$ are received by the detector array **14** in specific, isolated areas $84_1, 84_2, 84_3$.

[0020] FIGURE 7 depicts a cross-section of the CT scanner of FIGURE 6 to depict more clearly the axial separation of the x-ray tubes $90_1, 90_2, 90_3$. In the embodiment of Figures 6 and 7, a singe substantially continuous detector array **14** is mounted to the stationary gantry portion **A** to receive the x-ray beams generated by the x-ray tubes $90_1, 90_2, 90_3$. The x-ray beams $82_1, 82_2, 82_3$ are closely collimated to strike the single detector array **14** in locations angularly displaced from one another. Moreover, because the x-ray tubes are angularly spaced about the examination region **12**, each x-ray beam $82_1, 82_2, 82_3$ is received by the detector array **14** over a unique arc $84_1, 84_2, 84_3$. In other words, the x-ray beams $82_1, 82_2, 82_3$ do not overlap, so that the single detector array **14** can produce signals representative of the three separate beams.

[0021] In an alternate embodiment, a plurality of multiple anode element tubes, such as are illustrated by reference number **40** in FIGURE 4, are mounted in intervals around a plurality of rings of radiation detectors $14_1, 14_2, \ldots 14_n$ as illustrated in FIGURE 3. Again, the x-ray sources are spaced an appropriate distance such that each fan beam irradiates a unique arc segment of one of the rings. For example, three of the x-ray sources can be disposed about 120° apart around the examination region. As yet another option, a larger number of multiple anode x-ray tubes may be positioned around the subject and the various anodes gated on and off to prevent more than one beam from irradiating a common detector element of one of the rings.

[0022] Referring now to FIGURE 8 the x-ray tube assembly preferably includes a control circuit **100** for selectively powering the cathode assemblies **70**. A cathode controller **102** is electrically connected between the filament current supply **80** and the individual cathode assemblies **70**. The cathode controller **102** can be configured as a grid control tube, electrical switch circuit, or the like. A comparator **104** controls the cathode controller **102** based on selected inputs. Preferably the selected inputs include a profile input **106**, a thermal profile memory or look up table **108**, and a timer **110**. The profile input **106** is preferably an input source where a technician can select a desired imaging pattern based on diagnostic needs. For example, the profile input desired may be for all multiple fan beams to be used simultaneously providing a maximum number of image slices in the shortest time. On the other hand, the desired profile may be to alternate or cycle selected sub-sets of multiple fan beams, perhaps to cover a larger volume.

[0023] As a further example, the technician may desire a maximum number of slices within the temperature envelope of the x-ray tube assembly. In this event, the thermal profile memory **108** is accessed to estimate the time that the anode elements can be bombarded with electrons before a period of rest, or non-use must occur to facilitate removal of excess thermal energy. The memory **108** is preloaded with thermal curves specific to the anode elements of the tube. Then, when the tubes are powered, a timer **110** calculates the amount of time the individual cathodes have been on. This time allows the comparator to estimate thermal loading conditions of the anode elements in use by plotting the time onto the thermal profile memory.

[0024] Regardless of profile desired, the comparator **104** receives the inputs, determines the sequence of operation and controls the cathode controller **102** to individually select specific cathode assemblies **70**.

[0025] The illustrated multiple fan beam computed tomography system has a number of advantages. One advantage resides in significantly improved imaging time as compared with conventional single fan beam CT systems. Another advantage is that volumes can be imaged substantially in real time. Another advantage resides in the ability to use existing reconstruction algorithms to generate images.

Claims

1. A CT scanner comprising: a stationary gantry **(A)** portion defining an examination region **(12)**; a rotatable gantry **(C)** portion for selectively rotating about the examination region **(12)**; a plurality of anode elements **(60)** associated with the rotatable gantry portion **(C)** for selective bombardment by an electron stream generating a plurality of parallel x-ray beams **(30)**; a plurality of x-ray detectors **(14)** receiving the x-ray beams **(30)** which have passed through the examination region **(12)** and generating signals indicative of the x-ray beams received; and a reconstruction processor **(18)** processing the generated signals into an image representation.

2. A CT scanner as claimed in claim **1**, further including: a plurality of x-ray tubes **(40)** each including at least one of the plurality of anode elements **(60)** having at least one target face associated with at least one cathode assembly **(70)** disposed within a vacuum housing, the cathode assembly **(70)** being controlled by a controller **(102)** in response to a

control signal selectively generating the electron stream, each x-ray tube being mounted to the rotating gantry portion **(C)**, and spaced along an axis at a common angle relative to the examination region **(12)**; and at least one collimator **(42)** externally adjacent to one of the x-ray tubes **(40)**, where the collimator defines an opening having fan-shaped sides forming parallel fan-shaped x-ray beams **(30)**.

3. A CT scanner as claimed in claim 1, further including: a plurality of x-ray tubes **(90)** each comprising one of the plurality of anode elements having at least one target face associated with at least one cathode assembly disposed within a vacuum housing, the cathode assembly being controlled by a controller **(102)** in response to the control signal selectively generating the electron stream, wherein each x-ray tube is mounted to the rotating gantry **(C)** portion, the x-ray tubes **(90)** spaced along an axis at a plurality of predefined angles relative to the examination region **(12)**; and a collimator externally adjacent to each of the x-ray tubes **(90)**, where the collimator defines an opening having fan-shaped sides forming parallel fan-shaped x-ray beams **(82)**.

4. A CT scanner as claimed in any one of claims 1 to 3, wherein the plurality of x-ray detectors comprise a set of axially spaced continuous rings of detector elements **(14)** mounted to the stationary gantry **(A)** portion.

5. A CT scanner as claimed in any one of claims 1 to 3, wherein the plurality of x-ray detectors comprise axially spaced arcs of detector elements **(15)** mounted to the rotating gantry **(C)** portion, each arc opposite an apex of the x-ray beams **(30)**.

6. A method of diagnostic imaging comprising: concurrently generating a plurality of thin fan beams **(30)** of penetrating radiation; passing the plurality of thin fan beams **(30)** of penetrating radiation through an examination region **(12)** and concurrently rotating the fan beams **(30)** around the examination region **(12)**; detecting each of the fan beams **(30)** of radiation after it has passed through the examination region **(12)** and generating electronic signals indicative of an amount of radiation which passed through the examination region **(12)**; and reconstructing electronic signals into a volumetric image representation.

7. A method as claimed in claim 6, wherein the fan beams **(30)** of radiation are rotated about an axis of rotation and further including: causing relative axial movement along the axis **(2)** of rotation between the examination region and the parallel fan beams **(30)** of radiation.

8. A method as claimed in claim 6 or claim 7, wherein the thin fan beams **(30)** of radiation are parallel to others of the thin fan beams **(30)** and rotate about an axis of rotation and further including: continuously moving the examination region **(12)** and the parallel thin fan beams **(30)** of radiation along the axis **(2)** of rotation such that each of the parallel beams **(30)** of radiation traverse a spiral through the examination region.

9. A method as claimed in any one of claims 6 to 8, wherein the fan shaped beams **(30)** of radiation rotate about an axis **(2)** of rotation and wherein an apex of each of the fan shaped beams **(30)** lies along a common line parallel to the axis **(2)** of rotation.

10. A method as claimed in any one of claims 6 to 9, wherein an apex of at least some of the fan beams **(82)** is angularly offset around an axis **(2)** of rotation relative to an apex of others of the fan beams **(82)**.

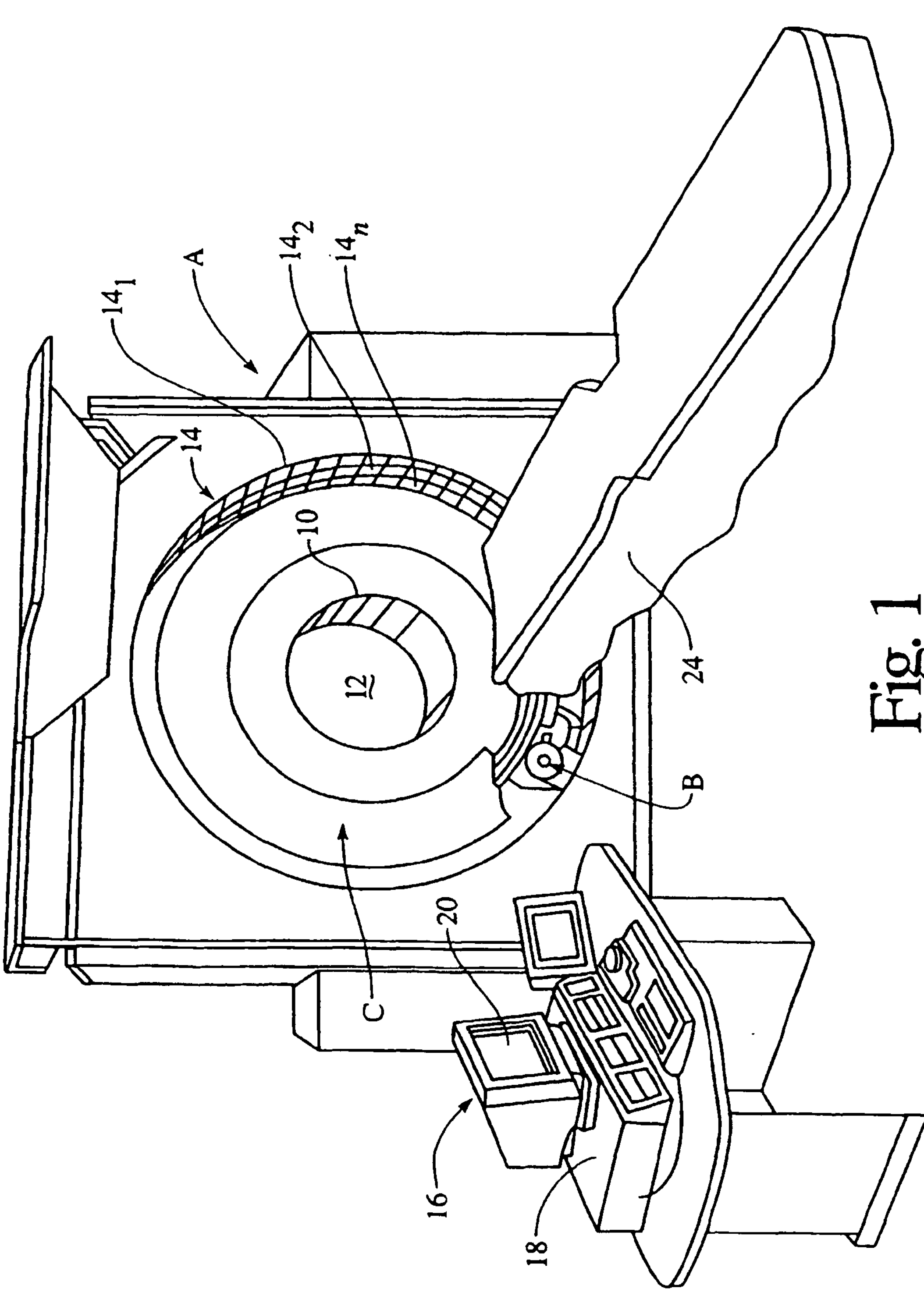


Fig. 1

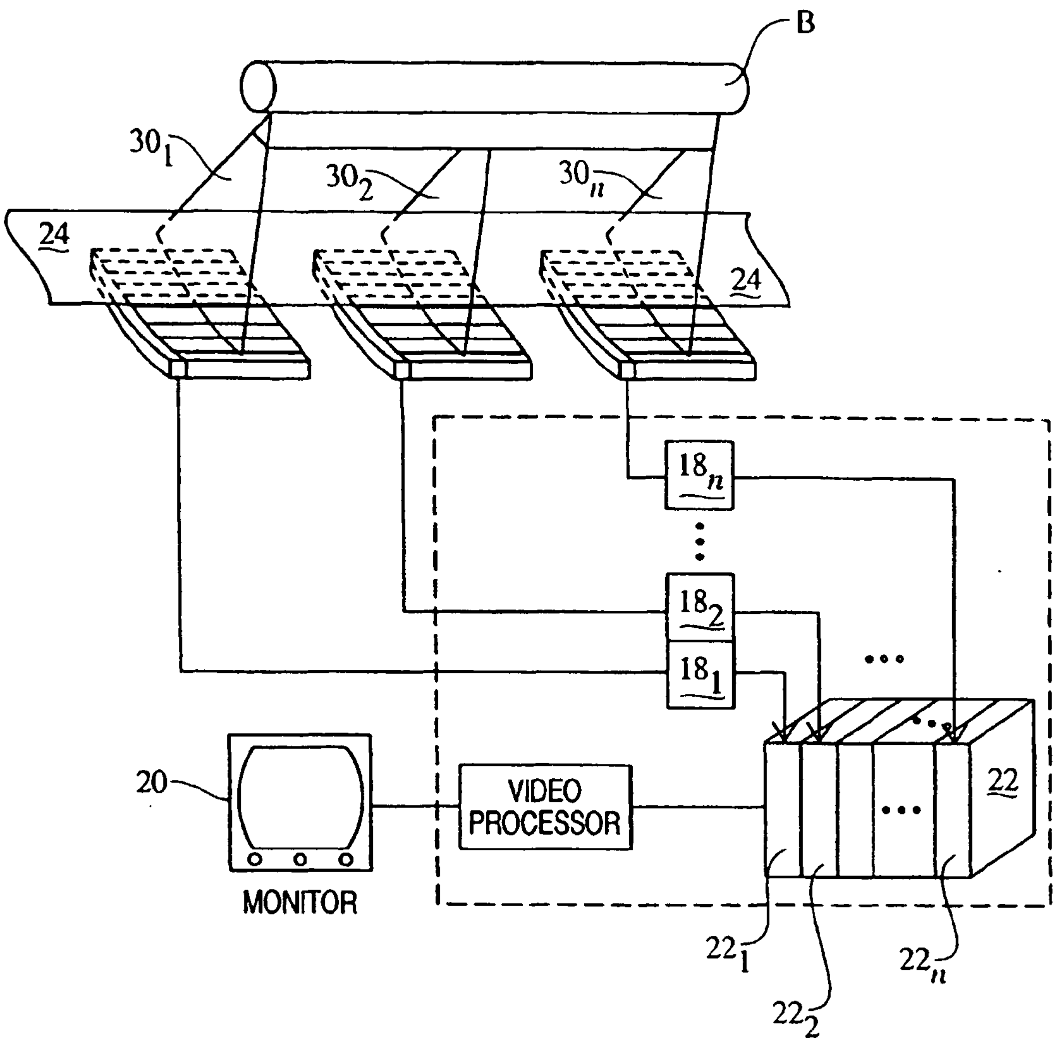

B
30_1
30_2
30_n
24
24
18_n
18_2
18_1
20
MONITOR
VIDEO PROCESSOR
22
22_1
22_2
22_n

Fig. 2

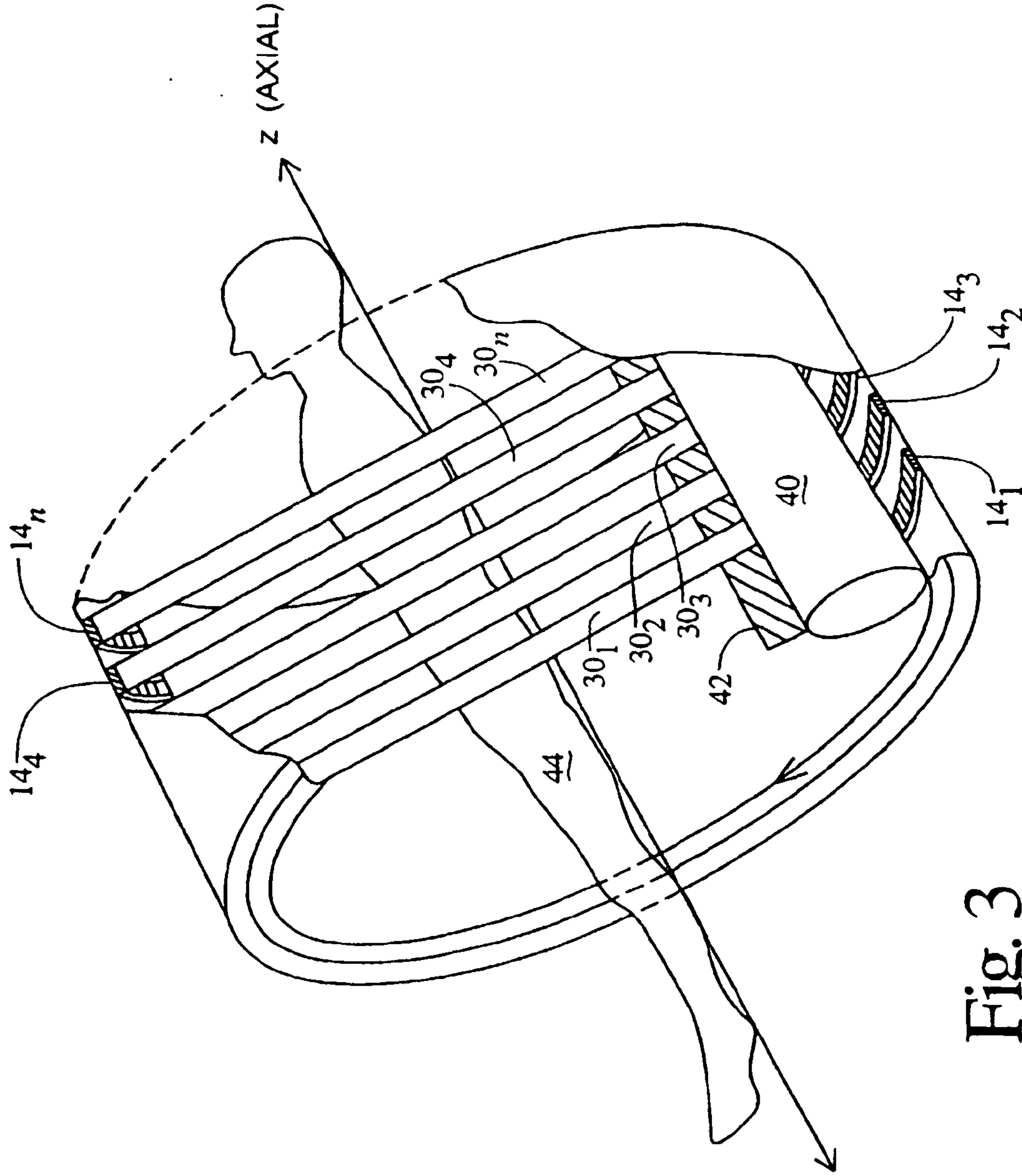
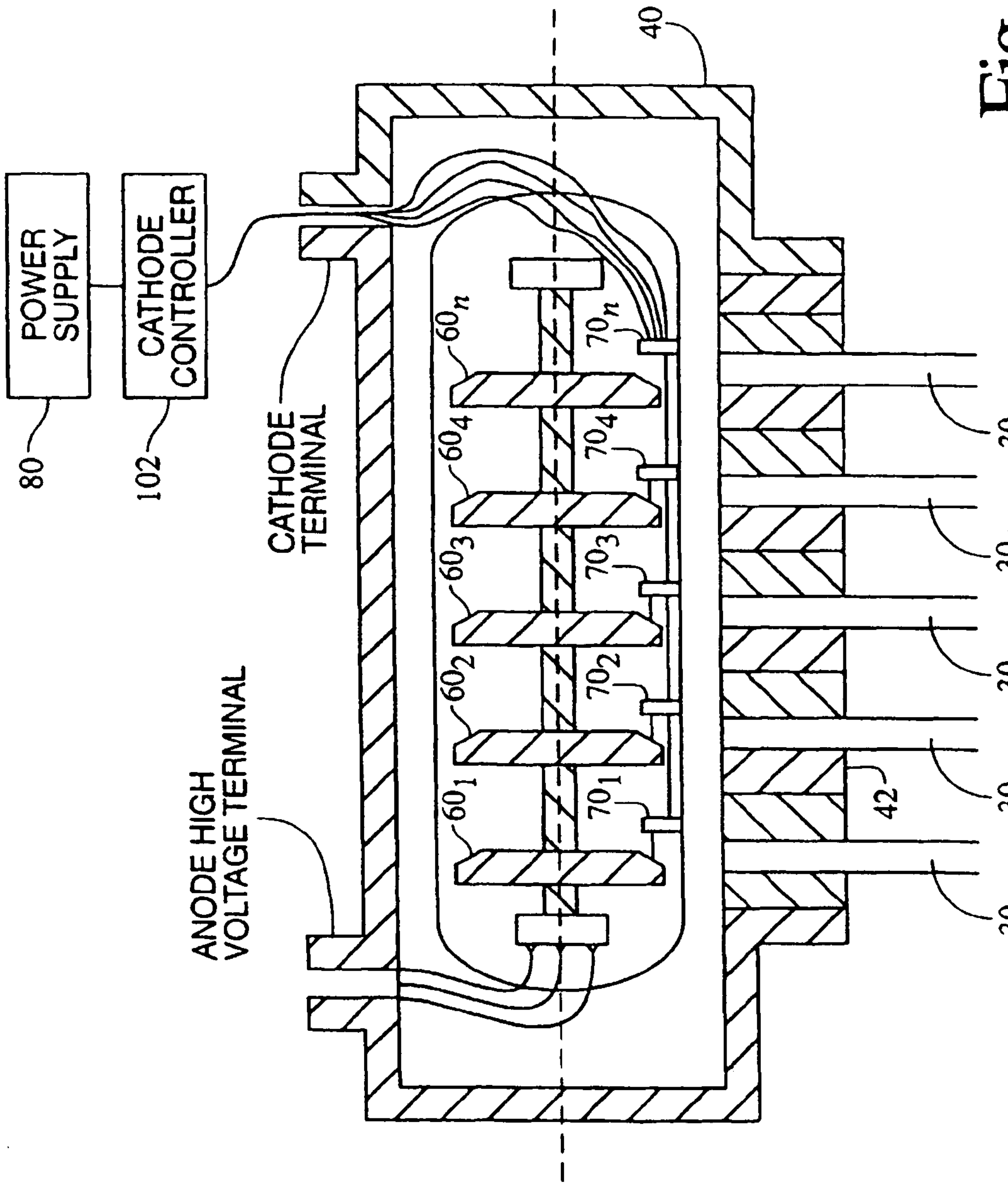


Fig. 3


POWER SUPPLY
CATHODE CONTROLLER
80
102
CATHODE TERMINAL
ANODE HIGH VOLTAGE TERMINAL
40
42
60_1
60_2
60_3
60_4
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30_4
30_n

Fig. 4

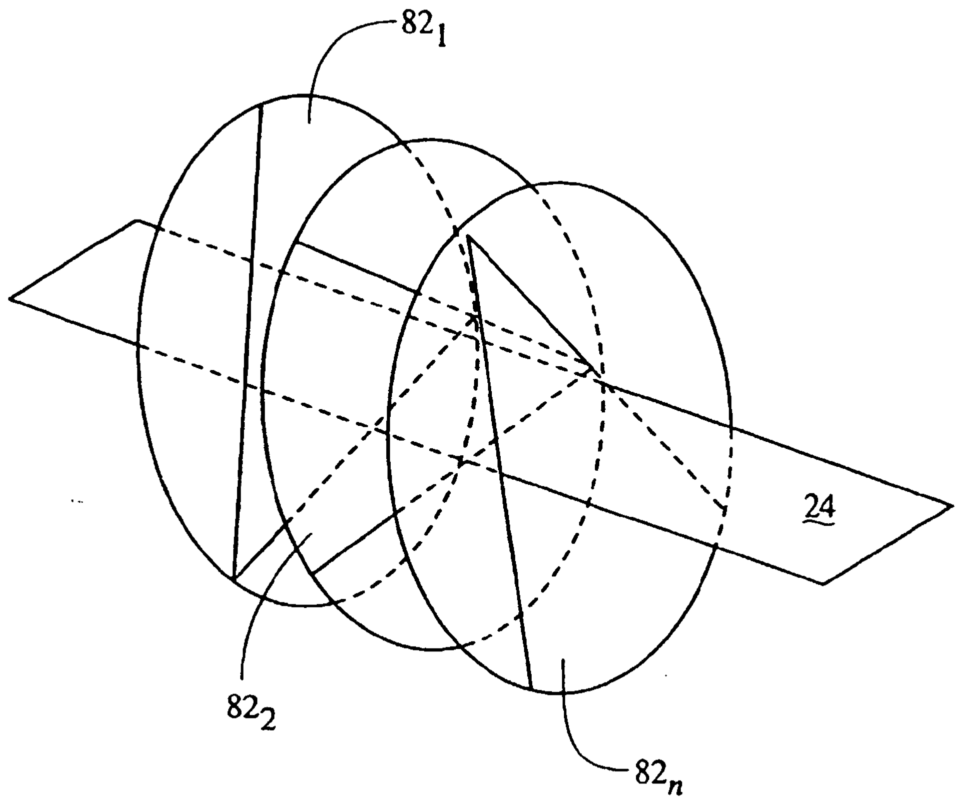
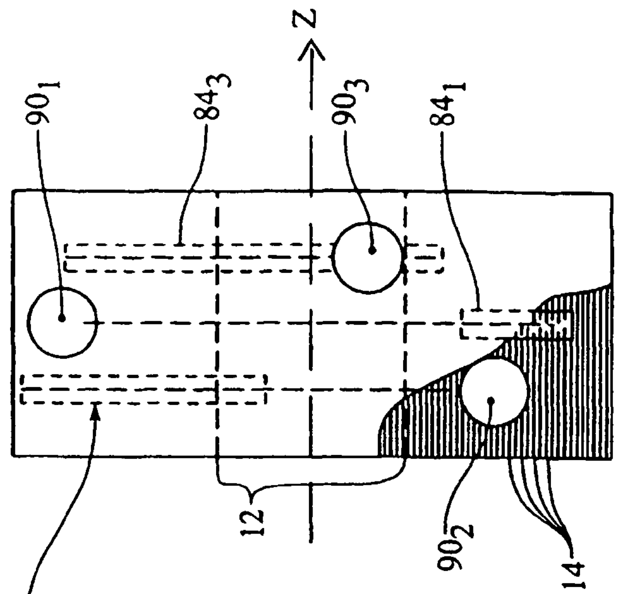


Fig. 5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90_3
84_1
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12
90_2
14

Fig. 7

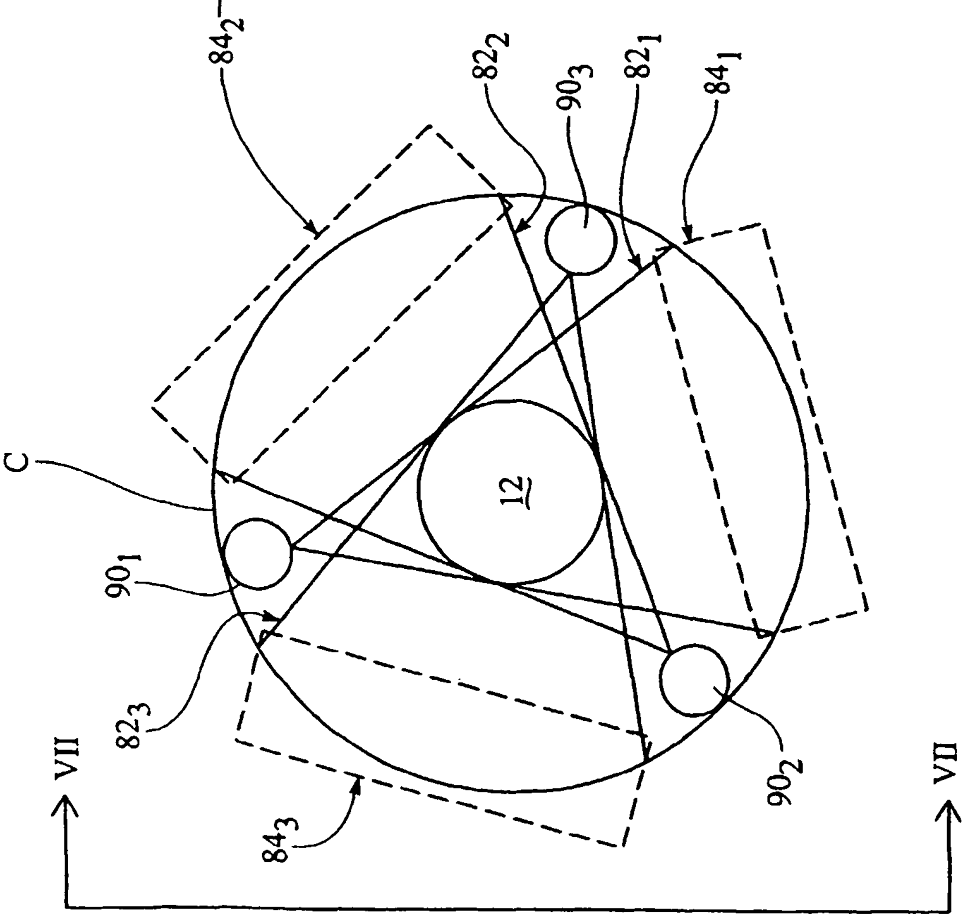
84_2
C
90_1
82_3
84_3
VII
VII
12
82_2
90_3
82_1
84_1
90_2

Fig. 6

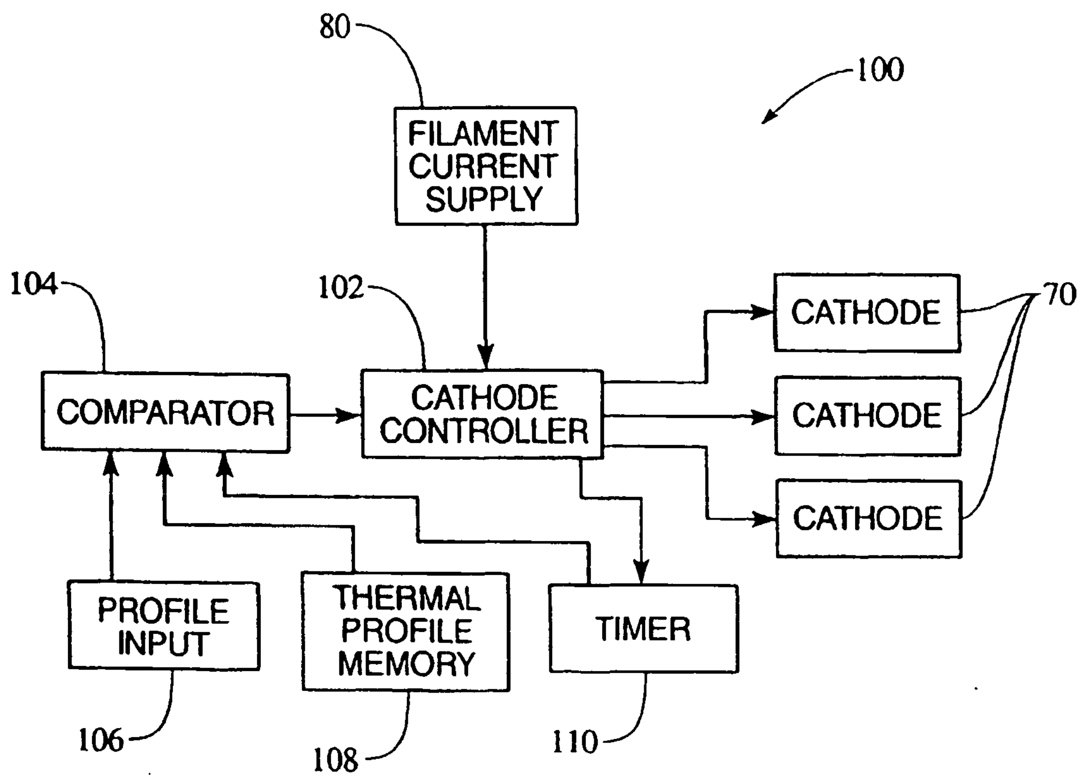
80
100
FILAMENT CURRENT SUPPLY
104
102
CATHODE
70
COMPARATOR
CATHODE CONTROLLER
CATHODE
CATHODE
PROFILE INPUT
THERMAL PROFILE MEMORY
TIMER
106
108
110

Fig. 8

(19) Europäisches Patentamt
European Patent Office
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(11) EP 1 005 257 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
11.06.2003 Bulletin 2003/24

(51) Int Cl.7: H05G 1/34, A61B 6/03

(43) Date of publication A2:
31.05.2000 Bulletin 2000/22

(21) Application number: 99308855.8

(22) Date of filing: 08.11.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 25.11.1998 US 199733

(71) Applicant: Marconi Medical Systems, Inc.
Highland Heights, Ohio 44143 (US)

(72) Inventor: Morgan, Hugh T.
Highland Heights, Ohio 44143 (US)

(74) Representative:
van der Veer, Johannis Leendert et al
INTERNATIONAAL OCTROOIBUREAU B.V.,
Prof. Holstlaan 6
5656 AA Eindhoven (NL)

(54) Computed tomography

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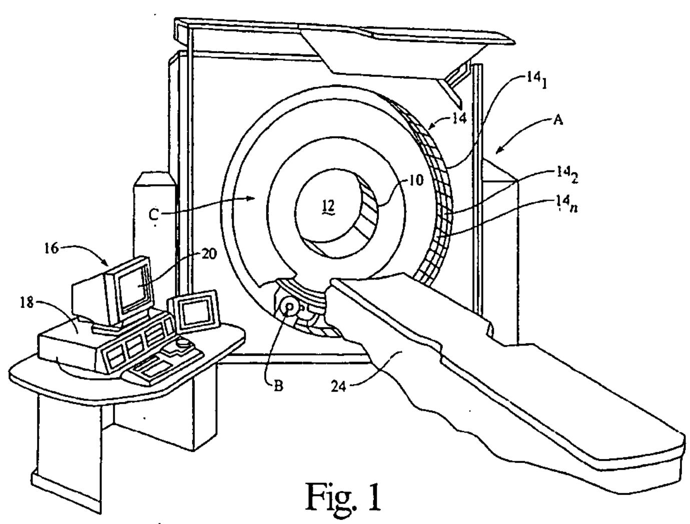

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 8855

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 31 09 100 A (SIEMENS AG) 30 September 1982 (1982-09-30) * page 3, line 18 - page 4, line 16; claims 1,3 * * page 5, line 22 - line 34 * * page 6, line 27 - line 29; figures 1,2,4 *	1-10	H05G1/34 A61B6/03
X	DE 42 24 249 A (ELSCINT LTD) 28 January 1993 (1993-01-28) * column 4, line 9 - column 5, line 20; claims 1,11,21,30; figures 1,3 * * column 6, line 39 - line 56 *	1-10	
A	GB 1 528 574 A (EMI LTD) 11 October 1978 (1978-10-11) * figure 2 *		
A	EP 0 025 982 A (SIEMENS AG) 1 April 1981 (1981-04-01) * figure 1 *		

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

A61B
H05G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	16 April 2003	Rodríguez Cossío, J

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 8855

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16-04-2003

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 3109100	A	30-09-1982	DE	3109100 A1	30-09-1982
DE 4224249	A	28-01-1993	DE	4224249 A1	28-01-1993
			FR	2679435 A1	29-01-1993
			JP	5184563 A	27-07-1993
			NL	9201325 A ,B,	16-02-1993
			US	6118839 A	12-09-2000
GB 1528574	A	11-10-1978	NONE		
EP 0025982	A	01-04-1981	DE	2938289 A1	02-04-1981
			EP	0025982 A2	01-04-1981
			JP	56052041 A	09-05-1981

EPO FORM P0459

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